Selected Bibliography on Ozone Disinfection

Research Report No. 29

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CANADA-ONTARIO AGREEMENT

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These RESEARCH REPORTS describe the results of investigations funded under the Research Program for the Abatement of Municipal Pollution within the provisions of the Canada-Ontario Agreement on Great Lakes Water Quality. They provide a central source of information on the studies carried out in this program though in-house projects by both Environment Canada and the Ontario Ministry of the Environment, and contracts with municipalities, research institutions and industrial organizations.

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SELECTED BIBLIOGRAPHY ON OZONE DISINFECTION

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ABSTRACT

A selected bibliography on ozone disinfection has been compiled. References are listed in alphabetical order and a subject-author index is included for the guidance of the user.

RÉSUMÉ

Le présent ouvrage comporte une bibliographie sur la désinfection à l'ozone. Les références sont données par ordre alphabétique et sont complétées par un index sujets-auteurs.

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1. USE OF THIS BIBLIOGRAPHY

This bibliography is arranged in alphabetical order by author and subject. To obtain references in any subject area, the user should select from the subject list the appropriate subject and this will indicate which references to search.

2. OZONE DISINFECTION

Ozone has been used since the beginning of the century to disinfect drinking water. Its first applications were in the city of Paris, France, and St. Petersburg, Russia (Anon, 1898). Now more than 500 municipalities in 50 countries use ozone for disinfection of drinking water (Evans, 1972). On the North American continent, chlorination is still the preferred method for the disinfection of drinking water, because it is economical and easier to control, and because it leaves bacteriostatic chloramine residuals. But with the development of ozone technology reducing installation and operating costs, ozonation of wastewaters may become even more economically attractive (Bowers et al, 1973). Some researchers suggested that the small amount of chlorine residual present can be nothing more than a placebo (Diaper, 1971; Whitson, 1950).

Ozone is a powerful oxidizing agent, second only to fluorine, with an oxidation reduction potential of about +2.07 volts. It is an excellent disinfecting agent which is able to inactivate viruses, bacteriophage, bacteria, fungi, yeasts, protozoa, spores and cysts rapidly (Sliter, 1974; Haeufele et al, 1973; Majumdar et al, 1973; Katzenelson et al, 1973; McBride et al, 1973; Pavoni et al, 1972; Carazzone et al, 1969; Gibson et al, 1960; Jones et al, 1952; Newton et al, 1949; Filippis, 1930).

Bringmann (1954) and Kinman (1971) maintain that ozone acts as a general protoplasmic oxidant; whereas chlorine selectively destroys or inhibits certain enzymes. However, it seems that disinfection does not occur unless an active level of ozone is attained (McClanahan, 1973; Diaper, 1973, 1972; Harris, 1972; Bauch et al, 1970b; Bischoff, 1968; Boucher et al. 1968; Sulzer et al, 1959; Fetner et al, 1959, 1956). For example polio viruses are inactivated in minutes by ozone, whereas chlorination takes hours (Majumdar et al, 1973; Coin et al, 1964; Kessel et al, 1943).

For water containing fine suspended solids, larger amounts of chlorine are needed than of ozone (Hopf, 1958). The short-lived ozonides (compounds formed by reaction of ozone and organics) also have germicidal properties (Druett et al, 1972; Dark et al, 1970; Heidt et al, 1964; Karabinos et al, 1955; Cronheim, 1947b; Ramel et al, 1938).

A further advantage of ozonation of water rather than chlorination is that large organic molecules may be broken down into smaller

organic molecules, deactivating some potential carcinogens (Il'nitskii et al, 1972, 1969; Korolev et al, 1972a,b; Gabovich et al, 1969) removing odours (Miller, 1966) and reducing BOD. Blogoslawski et al, (1973) mentions that a toxin produced by *Gymnodium breve* would be inactivated by ozone. Thus, certain organic compounds could be broken down to form more biodegradable compounds.

Recently, chlorination has received adverse publicity because of the possible production of toxic organic compounds (Arthur, 1971). Chlorine and its chloramine residuals are also toxic to water fauna to varying degrees (Doudoroff et al, 1950). Ozone, however, is unstable in water and decomposes rapidly, leaving no toxic residues. Buydens (1972, 1970) found that a rapid microbial regrowth occurred after ozonation, whereas, with chlorination, toxic chlorine derivatives could hinder regrowth (Boucher, 1967). In fact, ozone in very low concentrations (0.01 mg/l) will act as a stimulant to bacteria.

3. SUBJECT-AUTHOR INDEX

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